Chapter 2
Human-Robot Interaction in Organizations

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Abstract As advancement in technology is on the rise in organizational setting as observed in other areas, human-robot interaction is getting more focused in both academic and practical studies. Social robots influence business life deeply and hence human life by changing organizational settings. This study aims to explore how the interaction between humans and robots affects the workplace and in what aspects we can explain the nature of sociality and collaboration with robots. It also aims to put forward advantages and disadvantages of human-robot interaction by presenting essential reference points and discussing many aspects of human-robot interaction in organizations.

2.1 Introduction

Human-robot interaction has recently pointed out in academic research papers as well as in the practice in the fields such as robotics, posthumanism, cognitive psychology, design, engineering, etc. As practices and processes of Industry 4.0 have implemented in the organizations, the interaction between humans and robots become more usual, more practical and more experienced. In this context, it is vital to understand how robotic work partners affect workplace, which has been comprised of humans until now.

It is possible to see the robots in any organizations such as hotels, restaurants, retail shops, airports, etc. For example, humanoid service robots are designed to deliver service and interact with humans as their primary characteristics. Today Marriott, one of the biggest hotel chains, uses service robots for room service. On the other hand, Nestle provides sales service via service robots in the shops (Stock & Merkle, 2018). As these examples become normal and more apparent, not only practitioners (designers, engineers, data miner, etc.) but also academics who study

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on robotics science, psychology, organizational sociology, culture, etc. become interested in robotics field.

In this chapter, firstly the nature of intelligent systems will be explained and in this context the approach of machine learning will be mentioned. After that, it will be stated what differences between human and robots are and how the gap is closing today through integrating robotics science with other sciences such as neuroscience, psychology, cognitive science, development psychology, etc. Then, human-robot interaction will be set forth with many aspects and finally what working with co-worker robots (co-bots) brings for humans and organizations in a different setting.

2.2 The Nature of Intelligent Systems

While years ago robots were generally big in physical appearance and only one-task oriented in terms of competence, today intelligent machines are designed with multi-task oriented to collaborate with humans in the workplace and are used to even in small enterprises (Davenport & Kirby, 2015). Robots already have social roles in the organizational setting as teammates, co-workers, subordinates and so on.

Machines capable of performing cognitive tasks are more important than machines capable of doing physical work. Thanks to modern artificial intelligence, it is now possible to produce these machines. Our digital machines have begun to demonstrate their ability to break the chains that restrict them, to recognize patterns, to communicate in a complex way, and in other subjects that were previously monopolized by humans. It is not surprising to see that numerous artificial intelligence elements will either work on behalf of humans or take place in the background (Brynjolfsson & McAfee, 2015).

As a new direction for intelligent systems, there are some efforts to create artificial emotional characteristics for robots to get human-robot interaction better. A project titled as Artificial Emotional Creature was conducted by MIT Artificial Intelligence Lab and its main purpose was to produce a pet robot who had artificial emotions. In this project, it was developed through the integration of vision and audition, using the interaction of a human being with the robot as the training reference (Shibata & Irie, 1997).

Social and organizational theorists need to address what will happen to organizational issues when intelligent robots come to organizations. For the framework for social and organizational theorists, four paradigms are suggested from organization science. Structuralism, social networks, information process theory and contingency theory can be grounded to form a new organizational form with intelligent systems (Carley, 2002). In that case, the design of organizations should be revised according to complexity coming from the presence of intelligent robots.

The results of Carley's study (2002) propose that the increase in access to human and knowledge demonstrate a tendency to expand the time to acquire the most appropriate knowledge and to diffuse any part of this knowledge as human are engaged more in intelligent systems such as robots, artificial neural networks, applied algorithms, etc. in organizations. In addition to this, it is seen that performance is affected more negatively by the increase in the available knowledge in comparison to the rise of communication participants. Actually, it is a logical expectation about that the body of knowledge is getting expanded in comparison with humans in total.

Some factors such as data storage and digitalization of all data can play a role in presence of smart agents in organizations. According to Carley (2002), the important difference between use and access of information should be understood and properly differentiated from each other because the results surprisingly show that having more information in the hand makes the amount of access and learning of the information slower. Both people and smart agents have limited abilities to learn the information exactly. This is a sign of the dilemma for information expansion and information access.

On the basis of Carley's (2002) study, we can say that robots (avatars) are more serviceable in large organizations rather than in small ones because people are more open to communication in small groups. Actually, large organizations may be available for robots because much more workforce means a greater amount of communication so that robots can learn more than in small organizations. On the other hand, smart agents which cannot learn as expected can surprisingly communicate better among people. This is like databases becoming ineffectual in larger populations as they continue to alter and develop in matter.

As mentioned earlier, one of the most effective methods of digging the valuable information out of the big data is machine learning. In this technique, the computer processes and mines the data presented for it and it creates its own program according to the statistical relations discovered in a sense. Machine learning usually consists of two steps. Firstly, an algorithm is developed according to known data; then, it is asked to solve similar problems for the new information. Moreover, as new samples are getting inputs for the system, it can improve itself and adapt to the new environment and conditions (Ford, 2018).

Today one of the most striking examples of machine learning is Google's translate application. The algorithm of Google Translate is on the basis of 'rosetta stone' approach and examines and compares the millions of pages of texts which are translated into different languages. Firstly, Google team applied official documents prepared by The United Nations as data and then the team used documents translated into different languages that Google search engine found over the Internet. As a result, Google has created a wider range of language models than those created in human history so far (Ford, 2018).

Self-improving systems, on the basis of machine learning, are also new way of advancing artificial intelligence. Self-improvement of the systems lead to unpredictability of behaviors of intelligent machines (Omohundro, 2007). Today these systems may be very practical for humans as they are controlled by humans. Otherwise, for the future, learning machines will be perceived as threats for human because it is difficult to foresee the future of these systems.

2.3 Human Being Versus Robot Being

Intelligence is considered as the most important difference between humans and machines. However, today this gap is slowly closing between them by means of advancements in robotics science. Robotics science is contributed by several disciplines such as neuroscience, psychology, human sciences, cognitive science, engineering, computer science as well as technological developments such as artificial intelligence, machine learning, presence of big data, etc.

2.3.1 A Mixture of Human Sciences and Robotics

In their study regarding humanoid and android science, Ishiguro and Asada (2006) highlight that human anthropomorphize robots to communicate and interact well with them. They also emphasize the importance of appearance and behavior for interactive robots; on the other hand, they indicate that robotics science focus mostly on technical issues, not behavioral ones. According to the authors, developing and using a human-like robot (android) are getting easier to study related to the interaction between humans and robots. This contributes to not only robotics science but also cognitive science. Developing humanoid robots requires the accumulation of knowledge from sciences regarding humans such as sociology, psychology, social psychology and so on. In a similar way, the field of android science is formed by contribution from different disciplines like engineering and cognitive science. In the framework of this field, android robots can share information with humans by taking advantage of both robotics engineering and cognitive science. For better interaction between human and robots, it is substantial to understand conscious and unconscious identification of humans and then design robots according to human-like hardware and software. This effort is handled under the ‘humanoid science’.

Synergistic intelligence, one of essential concepts regarding humanoid and android science, means ‘intelligent behaviors that emerged through interaction with the environment, including humans’ (Ishiguro & Asada, 2006, p. 75). It presents the effort of exploring humans in a new way and a new understanding designing humanoid robots supported by interactive feedback between humanoid robots design and human science. Synergistic intelligence also necessitates self-developing characteristic for robots.

Cognitive robotics aspires after creating framework to engage human cognitive abilities to robots. The way of thinking enables robots to be better-designed according to humans’ cognitive abilities. This means that a robot is equipped by more cognitive abilities such as making rational decisions, setting up plans, respond reasonably to unexpected situations and issues, and adapting to changing factors as well as having flexible and self-developed behaviors (Thielscher, 2006). These competencies can also foster the interaction between humans and robots.

By being inspired from other disciplines of ethology, neuroscience and psychology, Velasquez (1999) tried to integrate robotics sciences with these fields and developed a computational framework. The researcher aimed to develop a model comprising significant viewpoints of emotional processing and combining it with perception, motor control, behavior and motivation models. In the study, it is thought that the main purpose is to be able to control various autonomous systems such as a robot which can express feelings.

2.3.2 Integrating Human's Social Abilities into Robots: Social Robots

Robotic technology has grown rapidly and robots take place in organizations. As a new type of intelligent robots, social robots are robotic machines that play social, assistive or therapeutic roles (van Oost & Reed, 2011). Breazeal (2004) defines a sociable robot as 'is able to communicate and interact with us, understand and even relate to us, in a personal way' (p. 1). Persson, Laaksolahti, and Lonnqvist (2002) use the term 'socially intelligent agents (SIA)' instead of social robots to draw attention to the nature of social intelligence and believable social interaction by making sense of real, fictive or artificial social settings.

Bartneck and Forlizzi (2004) define a social robot as 'an autonomous or semi-autonomous robot that interacts and communicates with humans by following the behavioral norms expected by the people with whom the robot is intended to interact'. On the basis of their own definition, they classified social robots and proposed a framework in terms of form, modality, social norms, autonomous and interactivity. According to the framework, some guidelines were revealed as a result of the study. For example, the social robot has such a form that is compatible with skills. It also should manage the communication flow with humans by using mimics like humans. Finally, the social robot should recognize the social rules pertaining to humans and improve several behaviors to meet the humans' sociality needs.

According to Steuer (1995), people act more responsively across to robots as they have some special characteristics similar to themselves. He asserted that there are five properties which makes human-robot interaction easier. They are human social rules, human-like physical appearance, interactivity, human sounding speech and natural language use. It is suggested that people use social behaviors and norms when interacting with robots.

For the purpose of evaluating social robots' social effectiveness, Steinfeld et al. (2006) determined metrics such as interaction characteristics, persuasiveness, trust, engagement and compliance. These metrics are respectively presented to assess the interaction style, behavior or attitude change, reliance, efficacy several social features, and cooperation.

In another study, Claure and Jung (2018) aimed to understand social dynamics existing among human-robot teams and conducted the robotic social attributes scale to 30 participants. The scale measures warmth, competence, discomfort, arousal, and performance of the robot perceived by human participants. It is clearly understood that people have different expectations regarding robots. To determine these expectations and to design robots in a way to meet the needs are very critical to place human-robot teams in an organization or any structure.

In her short paper titled 'Human-Robot Partnership', Breazeal (2006) from MIT Media Lab indicates that her favorite science fiction robots are the ones having social abilities because they facilitate human life. In her own words, social robots, as a new type of intelligent robots, must be 'natural and intuitive enough for the average customer to interact and communicate with human, work with as partners, and teach new capability' (p. 79).

On the basis of Breazeal's thoughts (2006), there are some challenges in regards to social robotics. First of all, robots who have social cognitive skills should understand humans in social-psychological concepts to value the objectives, beliefs, emotions, drivers, and all mental forms which explain basic reasons for human behaviors. The second one is robots' collaboration with humans as work partners. For effective collaboration, robots should behave on the basis of human social rules such as communication, participation and so on. Lastly, social robots are like social learners that learn from people. Social learning for robots is a process that includes learning new abilities from human partners, imitating human behavior, engaging the social processes like humans and so on.

Mataric (2006) seeks for an answer to the question 'what happens when intelligent robots and people share an environment and even goals?' (p. 81). The field of human-robot interaction may help to shed light on this question. For the first step, socially assistive robotics are suggested to overcome current issues in interaction between human and intelligent robots because they aim to help people socially, especially rehabilitation, training and education, in comparison to the physical needs. The robot's physical incarnation is critical to bring forth the quality of the human's reaction, not only in the theoretical studies but also practices. Characteristics and implementations of the incarnation provide more ways for research into both humans and interaction between humans and socially assistive robots. For example, it is very critical to explore how the robot looks, how it behaves and how it relates to the environment (Mataric, 2006).

Humans do not have hopes in regards to presence of sociable robots. The other side of the coin humans' fear from them. Deception and substitution are two important fears which humans have. The first one may become dangerous for mentally impaired elders and toddlers as robots have emotional believability. Secondly, humans assume that robots will take over jobs and lives belonging to them and replace them in all settings (van Oost & Reed, 2011).

Scassellati (2000) introduces that two main ideas which contribute to the intersection area between the fields of human development and artificial systems. First, developmental models regarding human beings can significantly contribute to the building of robotic systems which comprise of not only physical requirements such as robots, appearance, etc. but also perceptual and cognitive abilities. Second, these systems can be applied to understand and assess the models just like simulation researches are conducted to measure cognitive models. According to Scassellati (2000), models from developmental psychology frequently present 'behavioral decomposition and observations about task performance which may provide an outline for a software architecture.' (p. 1). For that reason, studies in regards to human skill advancement can be suited to determination of robotics systems. On the other hand, robotics, especially humanoid robots, can also lead to improvement of developmental psychology via exploring the nature of human intelligence more.

Tapus and Mataric (2007) study on the emulating and embodying empathy in socially assistive robots and how it is applied functionally. For this, authors determine four elements which a robot should have. These capabilities are recognizing, understanding and interpreting the other's emotional state, processing and expressing its emotions by using different modalities, communicating with others and perspective taking. Then, authors measure the empathy in robots with these components: empathic concern, perspective taking, fantasy and personal distress.

2.4 Human-Robot Interaction

Although robotics is a wide discipline, the efforts which can determine the human-robot interaction as a field have clearly been seen in the literature review since early 1990s. According to the definition by Goodrich and Schultz (2007, p. 204), 'human-robot interaction is a field of study dedicated to understanding, designing, and evaluating robotic systems for use by or with humans'. To explore a human-robot interaction survey, Goodrich and Schultz (2007) define problems of human-robot interaction in terms of autonomy, information exchange, teams, task shaping, finding a unifying theme and adaptation, learning and training and classify the types of human-robot interaction in terms of being collocated as remote interaction and proximate interaction (Goodrich & Schultz, 2007).

Kiesler and Hinds (2004), the most cited researchers studied on human-robot interaction, have highlighted some reasons why this field differs from human-computer interaction. The first reason for studying human-robot interaction is that humans perceive robots differently from other technological devices. Especially for the effort of getting robots more 'anthropomorphic', researchers are encouraged to understand which mental systems are appropriate for better human-robot interaction. Secondly, reactions and interactions differ in comparison with other computer technologies because of mobility and flexibility of robots. They have complex feedback mechanisms to respond variously to their users. The third one is machine learning abilities of robots. It is possible to say that both disciplines of human computer interaction and human robot interaction broadly study a sociological understanding of robots which accompany people.

The increase in studies in this field brings along new research questions and contradictions. For example, while scientists believed that human beings could distinguish only universal and basic emotions in previous years, today psychologists describe much more emotional distinctions to use in robotic design. This change is rooted in new and radical technological improvements such as machine learning, data science, etc. (Kiesler & Goodrich, 2018).

Human-robot interactions can push people to acquire strong feeling connections to robots. There is an assumption that if robots appear like humans, humans will treat them as if they were humans. These emotional embracements create human-robot involvement in the group. The engagement of robots in the organization and involvement as team members change the beliefs which were valid until today about human groups (Robert Jr & You, 2014).

Shibata (2004) studied human-robot interaction by comparing industrial and service robots and discussed whether every type of robot has interaction ability with humans in respect of their functionality. He presents a review including the nature, duration and psychological enrichment of human-robot interaction and some cases from several cultures.

Arkin, Fujita, Takagi, and Hasegawa (2003) examined human-robot interaction on the basis of ethological and emotional aspects. For the effective interaction, they suggested focusing on more motivational factors and then attain a greater ability which links between humans and robots. They also set forth that more natural human-robot interaction will be designed and emotionally grounded concept will be a key variable to understand the robots.

Sung, Christensen, and Grinter (2009) investigate the novelty effect in human-robot interaction and explore how long term use of robots affect the interaction by using a longitudinal field study including 30 households. The results indicate that human-robot interaction is stable enough especially in the first 2 months when human and robots have met. The second important result is that humans are becoming bored with interaction if the task is routine. The other result showed that human expect more creativity tasks from robots to be able to keep interacting with them well.

2.5 Working with Co-worker Robots (Co-bots)

How does technology, in particular robots, impact work life and organizations? Acceptance and carrying out of workplace technologies are affected by some concerns. One of which is on the basis of user friendliness of them. This characteristic affects directly the performance of people and drives the interaction between humans and technology. The other consideration is self-efficacy felt by people. As they have ability to use technology and experience the functional benefit of technology, they become open to new technology. The third concern is about being economical and low-cost of technology. New technology is getting more implemented by individuals as long as it provides benefit to the organizations and people. The last consideration is the role of social factors. If new technology is accepted by their social environment, people are having more willingness to adapt to it (Cascio & Montealegre, 2016). These factors have the importance of putting technology to organizations and then the process of providing to be accepted, adopted and performed by individuals. In a similar way, adoption to robots and collaboration with them in an organization have the same concerns for working people.

Redden, Elliott, and Barnes (2014) create the term ‘co-bots’ for co-worker robots who are team members working with humans in an organization. They have related competences with given jobs and significant roles in capacity of industrial organizations. Further to that, they are becoming social actors to the degree that they collaborate and harmonize with human. Today human resource management processes and tools such as work analysis, training and performance development are becoming valid for robots, too. In addition to this, motivation and teamwork are concepts that are expected by robots as well as humans (Coovert & Thompson, 2014). These developments and foresights bring to our mind the question how the future of organizational commitment, organizational citizenship behavior, work satisfaction, group behavior, trust, teamwork and similar concepts will be for co-bots.

As a teammate, robots should be accepted by humans so that humans interact properly with them, improve common mental and communicational models for interaction with robots, and develop trust relationships with them. As robots have more autonomous jobs, the need of humans equally decline and robots continue to learn the job more via machine learning (Cascio & Montealegre, 2016). In addition to this, the fear of job loss is another concern which humans face regarding the use of robots in the workplace. Blue collar workers may see them as rivals and show resistance to their existence. They are perceived as threats by white collar employees as well, especially finance and accounting tasks. On the contrary, some jobs will be still on people’s hands and they will continue to show success without the need of robots’ automation world. Davenport and Kirby (2015) assume that knowledge workers can accomplish some jobs which they and intelligent systems do not separately perform but they do with the cooperation with each other. Despite this difference of opinions, it must be known that human resources management tasks such as job analysis, job design, workforce planning, recruitment and staffing, training and development, performance management, compensation management and career management should be redesigned to meet the robots appropriately in an organization and manage the relationship between humans and robots.

In human-robot interaction context, it is vital to understand how robotic work partners affect the workplace which belonged to humans until now. Researchers studied some concepts such as trust, responsibility, guidance, design, etc. to catch clues for better collaboration between humans and robots. For example; it is expected that behaviors, cognitive abilities and appearances of robots affect human-robot interaction. A robot may look mechanical, animal or human. On the basis of this discrimination, the type of basic robot designs are respectively mechanoid, zoomorphic and humanoid (Dautenhahn, 2013). It is argued that humanoid robots will make the human-robot interaction better and present a more involved interplay in some studies (Breazeal & Scassellati, 1999; Brooks, 2002). So, it is suggested that users should be engaged in the design of robots and then understand their roles and functions for a contribution to human-robot interaction (Dautenhahn, 2013).

It is clearly seen that some robots, especially humanoid robots rather than machine-like robots, are better at collaborating more naturally with humans. In this case, humans depend on them and allocate responsibility in terms of using authority. Hinds, Roberts, and Jones (2004) shed light how physical appearance and relativeness of robots affect human-robot interaction in terms of willingness and responsibility taken by humans.

Their approach to accept new technologies affects people's degree of openness to work with robots (Hinds et al., 2004). In other words, being more engaged in new technologies and following them regularly render people more coherent with robots and more eager to collaborate with them. In the same way, Mutlu and Forlizzi (2008) investigate how organizational factors are affected in a hospital which uses robots. They assume that the more sensitive to social dimension the technology in the organization, the more negatively humans react and the more resistance they have. In addition to this, it is stated that sense-making in technology adaptation has an important role in human-robot interaction in organizations. The results of the study indicate that there is a difference between different units in how people incorporate the robot into their workflow and their perception and interaction with the robot. The authors developed a model demonstrating workflow (staff interruption), political (goals, interests), social/emotional (emotional tone of social relationships) and environmental (traffic and clutter in the environment) dimensions on the basis of patient profiles.

Hierarchy is one of the important dimensions of an organizational structure to understand who has power in the organizations. Hierarchy also brings about a couple of concepts such as authority, autonomy, span of command, etc. These concepts are undoubtedly critical when explaining how human-robot interaction is realized in organizational as well as social life. People's sense of responsibility about their work depends on their position (leader, supervisor, manager or worker) in the workplace. Here responsibility is the cumulative feelings of performing well on the task, ownership for the task and contribution to the task. According to Sande, Ellard, and Ross (1986), people at upper echelons see themselves as more adequate and more responsible for the task which they have to do. This is about being human, but working with robots or managing robots does not have the same behavioral environment. Upon this difference, Hinds et al. (2004) assume that people depend more on the robot partners and assume less accountability for the task when working with robots that are supervisors as compared with robots that are colleagues and subordinates.

Stock and Merkle (2018) examined the performance of humanoid service robots in comparison to service employees on the basis of role theory and expectancy disconfirmation paradigm. They also investigated how social robots' artificial innovative behaviors (facial, vocal and bodily) revealed different human-human (employee-customer) service relationship and how they affected the service performance. Their study (2018) presents comparable knowledge by describing a real work life problem in organizations and conclude that customers are positively affected by innovative behaviors of robots.

The presence of robots in organizations have changed how groups work in real life and brought new socio-technical problems between humans and robots (Robert Jr & You, 2014). In this context, the questions about how a robot discusses with human in a group work, realizes communication with humans and understand each person in the team are questions which come to the mind. The inclusion of robots may be an advantage or disadvantage for the team effectiveness. In addition to this, trust among team members may be affected negatively by depending on the numbers of robots in the actual team. We have limited knowledge and experience about all possible challenges because of the lack of practices in regards to human-robot interaction in real life so far.

2.6 Discussion

Due to the nature of human-robot interaction structure, a question comes up. What is the future research questions of this field? According to Kiesler and Goodrich (2018), there are many concepts that are needed to learn and study deeply. Some of them are humans' intentions, trust, cultural aspects, contribution, benefits or harms in regards to robots. On the other hand, advances in new algorithms, development in cognitive robotics, machine learning practices should be followed and considered when assessing the interaction between humans and robots. In addition to this, it is important to know how to catch the mutuality between human and robots in terms of sociality.

The measurement of how the human-robot interaction is crucial to get better design of robots and to be more harmonized with humans. The question which capabilities, functions and tasks that robots have while working are a necessary knowledge which should be answered for not only human-robot interaction but also interaction among robots.

Another important subject regarding human-robot interaction is non-accountability of robots to the human. For this, a law system is needed independent from states, cultures, diversity of human, etc. The dilemma is open to question.

Human beings may perceive the existence and potential of robots as threats for themselves. Cascio and Montealegre (2016) assume that various jobs which belong to humans will be performed by intelligent robots in the next 5 years. It is expected that this will change the actual economical understanding not only in separate economies but also as a whole global economy. It will also alter the structure of organizations, labor economics, organizational sociology, etc. by bringing breakthrough changes and challenges of all mechanisms in the world.

Actually the critical point is having a new technology in an organization. The main issue is how the implementation process of new technologies (in particular robots) is performed by considering psychological and human factors of the organization (Coovert & Thompson, 2014).

Many stakeholders question the power in their hands when robots are becoming involved as a part of organizations. Power in organizations is always critical to determine who are main actors or top decision makers. The change of the balance between autonomy and authority affects surely not only technical factors but also social factors such as commitment, power, authority, communication, conflict, collaboration and so on. All of these factors also influence the decision making process in organizations because of change of control.

It seems that the big data will have two very important results for knowledge-based professions. Firstly, in many cases, the data accumulated before can lead to direct automation of given tasks and works. Just as humans firstly examine the old records and then practice by trying to perform certain tasks when learning a new job; so too can the intelligent algorithms can successful in many samples by using the similar approach. The second and more significant impact of big data on knowledge-based jobs is about the ways of managing companies. Big data and estimation algorithms have the potential to reduce the number of knowledge-based jobs as well as changing the way of performing them. Human skills such as experience and reasoning will be replaced by predictions derived from the data. As top managers use data-based decision making algorithms more frequently, the need for a workforce including analysts and managers will be limited or decreased over time. Today, the knowledge workers of companies present their analysis with the information they have collected to the different levels of the managers. However ultimately, a single manager and a strong algorithm may implement more efficiently in such an environment. It seems that companies will be getting flat in the future compared to today. Middle managerial level will be eliminated and most of jobs which are performed by experts today will evaporate in the near future (Ford, 2018). These prediction about big data and of course the presence of robots will surely affect it.

As future directions, it is possible to say that we need theories to understand and explain human-robot interaction in groups and in organizations as a whole. Apart from traditional research designs, we can produce new ones including experiment, observation and simulation-based to study social drivers and team issues in human-robot teams. New robots can be developed more cheaply and more observably to test the human-robot interaction in organizations, so that new forms of robotics design are suggested for better human-robot interaction. We need studies which focus on the socio-technical issues (technical competences and social roles and norms) to make team collaboration, team coordination and team communication better in human-robot groups. To create a common framework, social and technical requirements should be considered and examined together. This provides not only thinkers who theoretically study on robots and human-robot interaction but also practically robot makers.

It is also essential to explore the difference between knowledge based workers and physical ability based workers in terms of their orientation to smart robots. In addition to this, pearls and pitfalls of the robots embedded in the organizations and working with human should be investigated in terms of group processes. Moreover, it is worth doing research about how team dynamics such as trust, cohesion and collaboration and the group performance vary from human-human groups to human-robot groups. All these research questions can be designed as a new research which contributes to and enriches the human-robot interaction field.

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